DOCUMENT RESUME

ED 474 446 SE 067 528

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TITLE	Feeling Good about Mathematics: Are There Sex Differences?
PUB DATE	2002-11-06
NOTE	12p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Chattanooga, TN, November 6-8, 2002).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Higher Education; Learning Motivation; *Mathematics Anxiety; Mathematics Instruction; Self Esteem; Sex Differences; *Student Attitudes

ABSTRACT

The effects of mathematics anxiety and gender on attitudes toward mathematics were examined using the Attitudes Toward Mathematics Instrument (ATMI). A sample of 134 students currently enrolled in mathematics classes in a state university was asked to complete the ATMI. Data were analyzed using a multivariate factorial model with four factors of mathematics attitudes as dependent variables (self-confidence, value, enjoyment, and motivation) and two independent variables, mathematics anxiety and gender. There was an overall significant effect of math anxiety on self-confidence, enjoyment and motivation with large effect size. Students with no math anxiety scored significantly higher in enjoyment than students with a great deal of math anxiety in self-confidence and in motivation. And students with some math anxiety scored significantly higher in motivation than those with a great deal of math anxiety. (Author)

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FEELING GOOD ABOUT MATHEMATICS:

ARE THERE SEX DIFFERENCES?

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Paper presented at the Annual Meeting of the
Mid-South Educational Research Association,
Chattanooga, Tennessee
November 6-8, 2002

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ABSTRACT

The effects of mathematics anxiety and gender on attitudes toward mathematics were examined using the Attitudes Toward Mathematics Instrument (ATMI). A sample of 134 students currently enrolled in mathematics classes in a state university was asked to complete the ATMI.

Data were analyzed using a multivariate factorial model with four factors of mathematics attitudes as dependent variables (self-confidence, value, enjoyment, and motivation) and two independent variables, mathematics anxiety and gender. There was an overall significant effect of math anxiety on self-confidence, enjoyment and motivation with large effect size. Students with no math anxiety scored significantly higher in enjoyment than students with a great deal of math anxiety. Students with no or little math anxiety scored significantly higher than students with some or a great deal of math anxiety in self-confidence and in motivation. And students with some math anxiety scored significantly higher in motivation than those with a great deal of math anxiety.

Feeling Good about Mathematics: Are there Sex Differences?

Introduction

The facts that gender differences exist in mathematics achievement and enrollment in mathematics courses are indisputable. Gender differences in mathematics have long been explained as deficits, particularly inferior spatial visualization among girls. Presumably, this could be a sex-linked characteristic of the brains of females. Justification for this point of view is often based on deficits found in boys, such as higher levels of reading disabilities and attention deficit disorder, which are presumed to be caused by endogenous factors. As a result, innate sexual deficits have long been used to justify differences between the sexes. As Friedrich Nietzsche was reported to have said, "When a woman becomes a scholar, there is usually something wrong with her sexual organs."

Boys and girls have similar mathematics and science proficiency scores on tests at the age of 9, but a gap begins to appear at around age 13, or at least this has been the trend over a period from 1973 to 1994 on the NAEP assessment. However, in 1994 there was no measurable difference in the math proficiency of 13-year-old boys and girls. If there was a problem in spatial visualization, it suddenly cleared up about a decade ago.

According to TIMSS results, among participating countries, girls and boys had similar average mathematics achievement scores. However, on the NAEP, 17-year-old females have consistently scored lower, on average, than 17-year-old males, and in 1994, they were 5 scale-score points lower than males. Even more interesting, average mathematics scores among 17-year-girls turned down between 1973 and 1982, but increased afterward, in 1994, to a level similar to the age cohort in 1973.

Students who do well in mathematics have more positive attitudes about the subject, thus they are likely to take courses in those subjects and may perform better. Attitudinal research has been limited and instruments have been lacking, but generally the questions asked of students show mixed findings about 13-year-old boys and girls. Linn & Hyde, (1989) reported that attitudes are more negative for girls earlier than age 13, but the Longitudinal Study of American Youth found no differences for 7th- grade students.

There are equally likely explanations for differences, which may be neurological or learned. The data above cast doubt on a neurological difference, mainly because of the inexplicable increase of girls' abilities over time. Students' attitudes are clearly important, but little is known about the differential dynamics that intervene to create significant differences. It is clear that career aspirations of boys and girls are quite different beginning around age 13, which reflects a social or cultural explanation, because girls at that age have virtually identical abilities in mathematics. Boys are twice as likely to say they want to become scientists or engineers, but girls express a preference for professional, business, or managerial occupations (U.S. Department of Education, 1990).

Enrollment patterns of college undergraduates clearly show that few students anticipate a career in science, mathematics or engineering, and very few major in mathematics. In fact, less than 1 percent of undergraduates major in math The Conference Board of the Mathematical Sciences (Lutzer & Maxwell, 2000) showed that bachelor's degrees granted in mathematics fell 19 percent between 1990 and 2000, although undergraduate enrollment rose 9 percent. Attitudinal research among college students has not been thoroughly investigated. This study was an effort to determine if

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there are gender differences at the college level, a level where there has been little research compared to that at the K-12 level.

Method

Subjects

The subjects were 134 undergraduate students enrolled in mathematics classes at a state university in the southeast. Seventy-one subjects were male and 58 were female. Five participants did not report their gender. Approximately 80% of the sample was Caucasian and about 20% African-American. The ages of the sample ranged from 17 to 34. Ten participants did not report their ages. All subjects were volunteers and all students in the classes agreed to participate.

Materials

The Attitudes Toward Mathematics Inventory (ATMI) consists of 40 items designed to measure students' attitudes toward mathematics (Tapia 1996). The items were constructed using a Likert-format scale of five alternatives for the responses with anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree. Eleven items of this instrument were reversed items. These items were given appropriate value for the data analyses. The score was the sum of the ratings.

A Student's Demographic Questionnaire was also used. This questionnaire consisted of four questions. The purpose of these questions was for identifying gender, age, ethnic background, and level of math anxiety. Level of math anxiety consisted of four previously identified levels (none, little, some, a great deal)

Exploratory factor analysis of the ATMI using a sample of high school students resulted in four factors identified as self-confidence, value, enjoyment, and motivation.

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Self-confidence consisted of 15 items. The value scale consisted of 10 items. The enjoyment scale consisted of 10 items. The motivation scale consisted of five items. Table 1 shows anchor items by factors. Alpha coefficients for the scores of these scales were found to be .95, .89, .89, and .88 respectively (Tapia 1996).

Procedure

The ATMI was administered to participants during their mathematics classes. Directions were provided in written form and students recorded their responses on computer scannable answer sheets.

Results

Tapia (1996) found a four-factor solution from an exploratory factor analysis with maximum likelihood method of extraction and a varimax, orthogonal, rotation. The names for the factors reported were self-confidence, value of mathematics, enjoyment of mathematics, and motivation. Based on that factor analysis, the 40 items were classified into four categories each of which was represented by a factor. A composite score for each category was calculated by adding up all the numbers of the scaled responses to the items belonging to that category. Cronbach alpha coefficients were calculated for the scores of the scales and were found to be .96 for self-confidence, .93 for value, .88 for enjoyment, and .87 for motivation.

The data were analyzed by using multivariate factorial model with the four factors as dependent variables: (1) self-confidence, (2) value, (3) enjoyment, and (4) motivation and two independent variables: (1) gender and (2) level of math anxiety. Multivariate analysis of variance (MANOVA) was performed by using SPSS.

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The linear model was written as,

SC VAL ENJ MOT = GEN + ANX + GEN*ANX where

SC = Self-confidence

VAL = Value of mathematics

ENJ = Enjoyment of mathematics

MOT = Motivation

GEN = Gender

ANX = Level of math anxiety

Data were analyzed testing for interaction effect and main effect at the .05 level. Data analysis indicated that the two-way interaction effect of the two variables GEN*ANX on the four dependent variables self-confidence, value, enjoyment, and motivation was insignificant with small effect size (Wilks' Lambda F= 1.117, $p < .35$, eta squared = .04). Hence, it was concluded that there was not enough evidence to indicate a two-way multivariate interaction. The results also showed that the main effect of gender was insignificant with small effect size but the main effect of mathematics anxiety was significant with large effect size. Table 1 shows F, p, and partial squared values for the interaction and main effects. So it was concluded that there was enough evidence to say that there was an effect of the variable level of math anxiety on the four dependent variables self-confidence, value, enjoyment, and motivation. Therefore, follow ups were conducted.

Table 1

Interaction and Main Effects Tests for SC VAL ENJ MOT = GEN+ ANX + GEN*ANX

Effect	Value	F	Hypothesis df	Error df	Significance	Partial Eta squared
GEN	.967	1.018	4.000	118.000	.401	.313
ANX	.523	7.237	12.000	312.490	.000	.033
GEN*ANX	.895	1.117	12.000	312.490	.345	.036

Table 2 shows that the effect of math anxiety to three of the four dependent variables was significant with large effect size. There was enough evidence to say that there was an effect of math anxiety on the variables self-confidence, enjoyment, and motivation. Table 3 shows students with no math anxiety scoring significantly higher in enjoyment than students with a great deal of math anxiety. Self-confidence was significant with students with no or little math anxiety scoring significantly higher than students with some or a great deal of math anxiety. Motivation was also significant with students with no or little math anxiety scoring significantly higher than students with some or great deal of math anxiety and student with some math anxiety scoring significantly higher than students with great deal of math anxiety.

Conclusions

The multivariate data analysis indicated that the two-way interaction effect of the two dependent variables Gender*MathAnxiety to the four dependent variables self-confidence, value, enjoyment, and motivation was insignificant. The data analysis also indicated that the effect of math anxiety on three of the four dependent variables was significant with large effect size. Hence there was enough evidence to say that there was an effect of math anxiety on the variables self-confidence, enjoyment, and motivation.

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Table 2

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Model	SELFCONF	357382.737[a]	8	44672.842	399.358	.000	.964
	VALUE	181022.539[a]	8	22627.842	401.023	.000	.964
	ENJOY	136808.628[b]	8	17101.079	307.401	.000	.953
	MOTIV	27945.802[c]	8	3493.225	225.286	.000	.937
GENDER	SELFCONF	112.005	1	112.055	1.002	.319	.008
	VALUE	43.763	1	43.763	.776	.380	.006
	ENJOY	181.764	1	181.764	3.267	.073	.026
	MOTIV	49.621	1	49.621	3.200	.078	.026
ANXIETY	SELFCONF	10455.327	3	3485.109	31.158	.000	.436
	VALUE	362.896	3	120.965	2.144	.098	.050
	ENJOY	1604.524	3	534.841	9.614	.000	.192
	MOTIV	613.037	3	204.346	13.179	.000	.246
GENDER* ANXIETY	SELFCONF	409.451	3	136.484	1.220	.305	.029
	VALUE	215.865	3	71.955	1.275	.286	.031
	ENJOY	74.575	3	24.858	.447	.720	.011
	MOTIV	76.468	3	25.489	1.644	.183	.039
Error	SELFCONF	13535.263	121	111.862			
	VALUE	6827.461	121	56.425			
	ENJOY	6731.372	121	55.631			
	MOTIV	1876.198	121	15.506			
Total	SELFCONF	370918.000	129				
	VALUE	187850.000	129				
	ENJOY	143540.000	129				
	MOTIV	29822.000	129				

a. R Squared = .964 (Adjusted R Squared = .961)
b. R Squared = .953 (Adjusted R Squared = .950)
c. R Squared = .937 (Adjusted R Squared = .933)

Table 3

Comparisons of Mean by Level of Math Anxiety

Math Anxiety	Self-confidence	Value	Enjoyment	Motivation
None	62.96	39.57	36.78	17.06
Little	57.64	38.11	34.37	16.14
Some	48.89	37.34	31.74	13.65
Great deal	36.42	34.33	26.08	10.88

Students with no math anxiety scored significantly higher in enjoyment than students with a great deal of math anxiety. Self-confidence was significant with students with no or little math anxiety scoring significantly higher than students with some or a great deal of math anxiety. Motivation was also significant with students with no or little math anxiety scoring significantly higher than students with some or great deal of math anxiety and student with some math anxiety scoring significantly higher than students with great deal of math anxiety.

Applications and Implications

While girls at various ages may have cultural or social pressures that help shape their attitudes about mathematics as a subject of study or an element in a future career, results with this sample of college-age students showed that the main effect of gender was insignificant. From these results, we conclude that feeling good about mathematics is not related to gender among this group of college students, but rather it is likely to be something related to individual, personal experiences.

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